

The LHCb Upgrade

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The flavour sector offers a very rich programme to search for physics beyond the Standard Model in a complementary way to the direct particle searches carried out at ATLAS and CMS. The recent LHCb results in the beauty and charm sectors have shown the potential of flavour Physics at LHC and the excellent performance of the detector. Thanks to its forward geometry, LHCb covers a complementary pseudo-rapidity range to the one of ATLAS and CMS. An upgrade of the LHCb detector is foreseen during the long shutdown expected in 2018 [1]. The current preliminary schedule of LHC and the expected integrated luminosity in LHCb are shown in Fig. 1. In the upgrade phase LHCb intends to collect about 50 fb^{-1} [2]. These data would allow to fully exploit the flavour physics potential and extend the programme to a general-purpose detector for the forward region. More details on the physics programme and the motivation can be found in [3, 4].

The current LHCb trigger is made of two stages, the Level-0 (L0) and the High Level Trigger (HLT). The L0 reduces the data rate from 40 MHz to 1 MHz. It is based on custom electronics receiving dedicated information from the calorimeters and from the muon chambers. The HLT is a software trigger running on a dedicated CPU farm. It receives the full detector information at 1 MHz and it reduces the rate down to a few kHz. Thanks to the full event reconstruction done at HLT, this trigger allows to select inclusive or exclusive heavy-quark decays, with a selection close the offline one.

In the upgrade [2], the full detector readout at 40 MHz will allow to have a fully flexible software trigger with a data rate up to 20 kHz at the storage. This will allow to increase the annual signal yield by about a factor 10 for the leptonic channels and by a factor 20 for hadronic channels. These yields will offer a statistical sample able to reach experimental sensitivities for many observables comparable or even better than their theoretical uncertainties. These data would also allow to exploit a wide physics programme beyond the beauty and charm sectors, e.g.: lepton flavour violation (Majorana neutrino, LFV in τ decays); electroweak physics ($\sin 2\theta_{eff}^{lept}$, M_W); exotic searches (hidden valleys); QCD (central exclusive production).

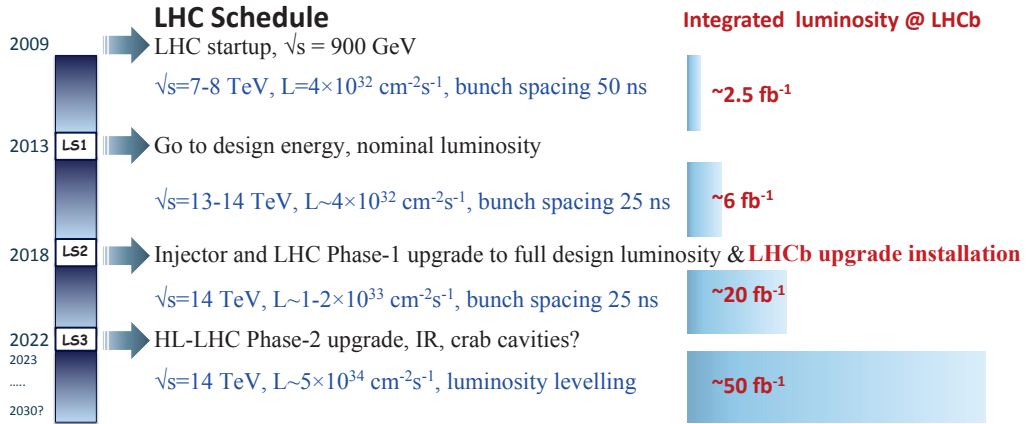


Figure 1: The current preliminary schedule of LHC and the expected integrated luminosity in LHCb.

The vertex detector (VELO) is a silicon strip detector with r and ϕ geometry. For the upgrade, two options are under study: a pixel detector (pixel size of $55 \mu\text{m} \times 55 \mu\text{m}$) based on the Timepix chip [5] and a silicon strip detector with a smaller pitch and strip length than the current detector. The tracker detector (TT) upstream of the magnet is a silicon strip detector. In the upgrade the same technology will be used with a wider acceptance and larger granularity. The tracker detectors (IT and OT) downstream of the magnet are composed by a silicon-strip detector in the inner region and a straw tubes detector in the outer region. In the upgrade the straw coverage will be reduced and the inner detector will be replaced with a scintillating fiber tracker or a larger silicon tracker.

The particle identification system is composed by two RICH detectors, a hadron and electromagnetic-calorimeter and by a set of muon chambers. The RICH photon detector will be replaced by a multi-anode photomultiplier to allow readout at 40 MHz. The front-end electronics of the calorimeters will be replaced, while the muon systems will almost remain unchanged.

In the LHCb upgrade, the tracking performance should remain at the same current performance level. This includes a high momentum resolution of $\Delta p/p = 0.4\% - 0.6\%$, high tracking efficiency ($\sim 96\%$ for $p > 5 \text{ GeV}$) with a low ghost rate ($\sim 15\%$ without any selection). As well, the full event reconstruction in the trigger will continue to have a fast processing time of about 30 ms.

The LHCb upgrade is under preparation: an expected integrated luminosity of 50 fb^{-1} will allow to have unprecedented precision in the flavour physics measurements and to extend the current physics programme.

References

- [1] LHCb Collaboration, R. Aaij et al., CERN-LHCC-2011-001
- [2] LHCb collaboration, CERN-LHCC-2012-007, LHCb-TDR-012
- [3] LHCb Collaboration, T. Gershon et al., LHCb-PUB-2012-006
- [4] LHCb Collaboration, T. Gershon et al., LHCb-PUB-2012-009
- [5] J. Buytaert et al., LHCb-PUB-2011-010